

CHAPTER 2

PRELIMINARY DESIGN DATA

2-1. **Investigation.** Before commencing with the design, complete investigations of the climatic conditions, topographical conditions, subgrade conditions, borrow areas, disposal areas, and sources of subbase, base, paving aggregates, and other paving materials of construction should be made.

a. **Previous investigations.** Previous subsurface investigations, pavement evaluation reports, construction records, and condition surveys from division, district, station files, and local paving agencies should be utilized to the maximum advantage possible.

b. **Publications.** Publications and other information from governmental agencies and professional societies as well as state agencies that may define surface and subsurface conditions and drainage patterns should be obtained. (See table 2-1).

Table 2-1. Sources of Information for Preliminary Subsurface Investigations

<u>Available Material</u>	<u>Source</u>
Geologic maps; topographic maps; U.S. Geological Survey (USGS). maps of surface material; aerial photographs	See "USGS Index to Publications," Superintendent of Documents, Washington, DC 20402
Soil maps; reports; aerial photographs	U.S. Department of Agriculture (USDA). See "Bulletin 22-R Transportation Research Board" for listings
Aerial photographs; topographic features of coastal areas	National Oceanic and Atmospheric Administration (formerly U.S. C&GS), Rockville, MD 20852
Bulletins; papers on geological subjects	Geological Society of America (GSA) P.O. Box 1719, Boulder, CO 80302. Consult index to GSA

c. **Field reconnaissance.** A field reconnaissance with the available topographical, geographical, and soil maps; aerial photographs; meteorological data; previous investigations; condition surveys; and pavement evaluation reports should be made. This step should precede an exploratory boring program.

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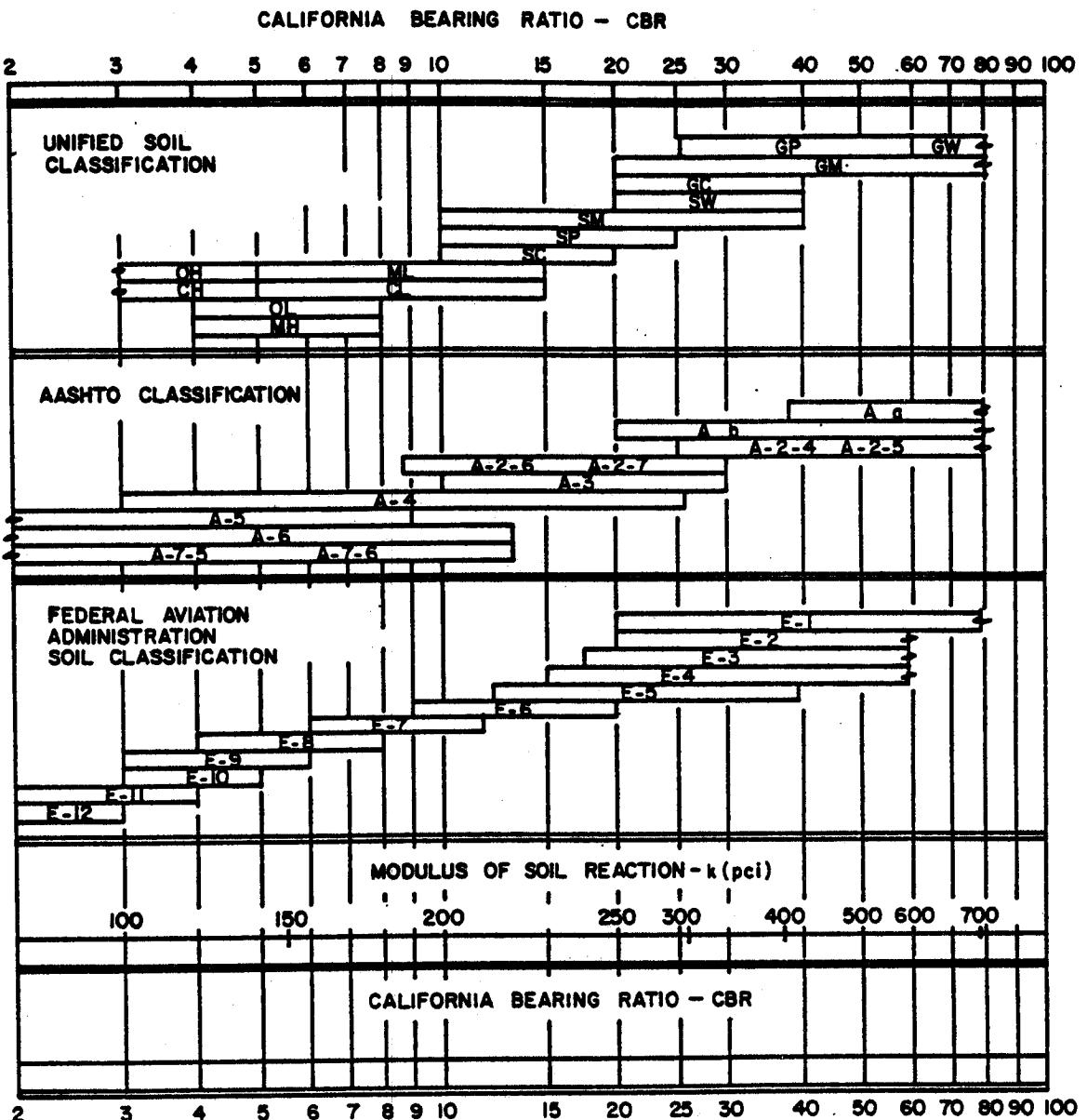
2-2. Exploratory borings. Exploratory borings according to the spacings and depths given in table 2-2 should be conducted. These are minimum values and should be supplemented with additional or deeper borings to cover unusual features. See figure 2-1 and table 2-3 for typical soil profiles and soil characteristics. Use figure 2-1 for approximate relationships between soil classifications and soil strength values when actual test results or existing information is not available.

Table 2-2. Minimum Requirements for Spacing and Depth of Exploratory Borings

<u>Item</u>	<u>Spacing Requirements</u>
Runways and taxiways less than 200 feet wide	200 to 300 feet on center longitudinally, on alternating sides of the centerline
Runways 200 feet wide or greater	two borings every 200 to 300 feet longitudinally, one boring 50 feet on each side of the centerline
Parking aprons and pads	one boring per 10,000-square foot area
<u>Item</u>	<u>Depth Requirements</u>
Cut areas	to a minimum of 10 feet below finished grade
Shallow fill (areas where not more than 6 feet of fill will be placed)	to a minimum of 10 feet below existing ground surface
High fill areas	to 50 feet below existing ground surface or to rock

2-3. Soil classification and tests.

a. Soil classification. All soils will be classified in accordance with the Unified Soil Classification System. There have been instances where the use in construction specifications of such terms as "loam," "gumbo mud," and "muck" have resulted in misunderstandings. These terms are not specific and are subject to different interpretations throughout the United States. Such terms will not be used unless properly identified. Sufficient investigations will be performed at a particular site so that all soils to be used or removed during construction can be described in accordance with the Unified Soil



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FIGURE 2-1. APPROXIMATE INTERRELATIONSHIPS OF SOIL CLASSIFICATION AND BEARING VALUES

TABLE 2-3. Soil Characteristics Pertinent To Roads and Airfields

Major Divisions (1)	Symbol (2)	Letter Matching (3)	Matching Color (5)	Soil Type (6)	Performance Value as Subgrade When Not Subject to Frost Action (7)		Performance Value as Subgrade When Not Subject to Frost Action (8)	Performance Value as Subgrade When Not Subject to Frost Action (9)	Potential Frost Action (10)	Compressibility and Expansion (11)	Drainage Characteristics (12)	Compaction Equipment (13)	Unit Dry Weight in per cu. ft. (14)	Subgrade Material in per cu. in. (15)	
					Excellent	Good									
GRAVEL AND GRAVELLY SOILS	GR	G	Pay	Well graded gravel or gravel-sand mixtures, little or no fines	Good to excellent	Good	Good	Good	None to very slight	Almost none	Excellent	Crawler-type tractor, rubber-tired roller, steel-wheeled roller	115-145	~0-80	100-500
	GP	G	Pay	Poorly graded gravel or gravel-sand mixtures, little or no fines	Good to excellent	Good	Fair to good	Fair to good	None to very slight	Almost none	Fair	Crawler-type tractor, rubber-tired roller, steel-wheeled roller	110-130	10-40	300-500
	G	G	Pay	Silty gravels, gravel-sand-silt mixtures	Good to excellent	Good	Fair to good	Fair to good	Slight to medium	Very slight	Fair to poor	Rubber-tired roller, sheepfoot	115-145	~0-40	100-500
	GS	G	Pay	Clayey gravels, gravel-sand-silt mixtures	Good	Fair	Fair	Poor to not suitable	Slight to medium	Slight	Poor to practically impermeable	Rubber-tired roller, sheepfoot	115-135	~0-40	200-500
	CC	CC	Pay	Well graded sands or gravelly sande, little or no fines	Good	Fair	Poor to not suitable	Poor to not suitable	Slight to medium	Slight	Poor to practically impermeable	Rubber-tired roller, sheepfoot	110-145	~0-40	200-500
	SW	SW	Pay	Poorly graded sands or gravelly sande, little or no fines	Fair to good	Fair	Fair to good	Poor	None to very slight	Almost none	Excellent	Crawler-type tractor, rubber-tired roller	110-130	20-40	200-400
	SP	SP	Pay	Silty sand, sand-silt mixture	Fair to good	Fair	Poor to not suitable	Poor to not suitable	Slight to medium	Almost none	Fair	Rubber-tired roller, sheepfoot	105-115	10-40	100-400
	SS	S	Pay	Silty sand, sand-silt mixture	Fair to good	Fair	Fair to good	Poor	Slight to high	Very slight	Fair to poor	Rubber-tired roller, sheepfoot	120-135	15-40	100-400
	SC	S	Pay	Clayey sand, sand-clay mixtures	Fair	Poor to fair	Poor	Not suitable	Slight to high	Slight to medium	Poor to practically impermeable	Rubber-tired roller, sheepfoot	100-110	10-20	100-400
	SL	SL	Pay	Inorganic silts and very fine sande, rock flour, silt or clayey fine sande or clayey silts with slight plasticity	Poor to fair	Poor to fair	Not suitable	Not suitable	Medium to very high	Slight to medium	Poor to medium	Rubber-tired roller, sheepfoot	100-115	5-20	100-400
SANDY AND SANDY SOILS	SLT	SL	Pay	Inorganic clays of low to medium plastici- ty, sandy clays, silty clays, silty clayey, loamy clays	Poor to fair	Poor to fair	Not suitable	Not suitable	Medium to high	Medium to high	Fair to poor	Rubber-tired roller, sheepfoot	90-110	15-40	100-200
	CL	CL	Pay	Organic silts, siliceous or dolomitic fine sande or silty soils, elastic silts	Poor	Poor	Not suitable	Not suitable	Medium to high	Medium to high	Practically impermeable	Rubber-tired roller, sheepfoot	90-110	15-40	100-200
	CLT	CL	Pay	Inorganic clays of high plasticity, fat clays	Poor to fair	Poor to fair	Not suitable	Not suitable	Medium to very high	Medium to high	Fair to poor	Rubber-tired roller, sheepfoot	80-105	10-40	100-200
	CLT LESS THAN 50	CL	Pay	Organic silts and organic silts-clays of low plasticity	Poor	Poor	Not suitable	Not suitable	Medium to high	Medium to high	Fair to poor	Rubber-tired roller, sheepfoot	80-105	10-40	100-200
	CLT 50 TO 100	CL	Pay	Inorganic silts, siliceous or dolomitic fine sande or silty soils, elastic silts	Poor	Poor	Not suitable	Not suitable	Medium to very high	Medium to high	Fair to poor	Rubber-tired roller, sheepfoot	80-105	10-40	100-200
	CLT 100 TO 150	CL	Pay	Inorganic clays of high plasticity, fat clays	Poor to fair	Poor to fair	Not suitable	Not suitable	Medium	High	Practically impermeable	Rubber-tired roller, sheepfoot	80-115	15-40	100-200
FINE- GRAINED SOILS	SLTS	SL	Pay	Organic clays of medium to high plasticity, organic silts	Poor to very poor	Poor to very poor	Not suitable	Not suitable	Medium	High	Practically impermeable	Rubber-tired roller, sheepfoot	80-110	5-20	100-200
	SLT AND CLATS LL	SL	Pay	Peat and other highly organic soils	Not suitable	Not suitable	Not suitable	Not suitable	Very high	Very high	Fair to poor	Compaction test practical	-	-	-
	CLATS LL IS GREATER THAN 50	CL	Pay	Peat and other highly organic soils	Not suitable	Not suitable	Not suitable	Not suitable	Very high	Very high	Fair to poor	Compaction test practical	-	-	-
	HIGHLY ORGANIC SOILS	PT	Pay	Peat and other highly organic soils	Not suitable	Not suitable	Not suitable	Not suitable	Very high	Very high	Fair to poor	Compaction test practical	-	-	-

1. Column 3, division of GR and SH groups into subdivisions of d and u are for roads and airfields only. Subdivision is on basis of Atterberg limits: suffix d (e.g., CHd) will be used when the liquid limit is 25 or less and the plasticity index is 5 or less; the suffix u will be used otherwise.

2. In column 13, the equipment listed will usually produce the required densities with a reasonable number of passes when moisture conditions and thickness of soil are properly controlled. In some instances, several types of equipment are listed because variable soil characteristics within a given soil group may require different equipment. In some instances, a combination of two types may be necessary.

3. Processed base materials and other angular materials. Steel-wheeled and rubber-tired rollers recommended for hard, angular materials with limited tires or screening.

4. Rubber-tired equipment is recommended for rolling out thin topsoil or materials subject to degradation.

5. Finishing. Rubber-tired equipment is recommended for rolling out thin topsoil or materials subject to degradation.

6. Compaction. The following lists of equipment are available to assure the required densities.

7. Crawler-type tractor - total weight in excess of 10,000 lb. wheel load at a pressure of approximately 65 to 150 psi (10,000 lb. wheel load at a pressure of approximately 65 to 150 psi).

8. Rubber-tired equipment - total weight in excess of 10,000 lb. wheel load at a pressure of approximately 65 to 175 psi (10,000 lb. wheel load at a pressure of approximately 65 to 175 psi).

9. Shovel or backhoe - total weight in excess of 40,000 lb. unit pressure as high as 65 psi may be necessary to obtain the required densities.

10. Shovel or backhoe - unit pressure as high as 65 psi (10,000 lb. wheel load at a pressure of approximately 65 to 175 psi).

11. Shovel or backhoe - unit pressure as high as 65 psi (10,000 lb. wheel load at a pressure of approximately 65 to 175 psi).

12. Shovel or backhoe - unit pressure as high as 65 psi (10,000 lb. wheel load at a pressure of approximately 65 to 175 psi).

13. Shovel or backhoe - unit pressure as high as 65 psi (10,000 lb. wheel load at a pressure of approximately 65 to 175 psi).

14. Shovel or backhoe - unit pressure as high as 65 psi (10,000 lb. wheel load at a pressure of approximately 65 to 175 psi).

15. Shovel or backhoe - unit pressure as high as 65 psi (10,000 lb. wheel load at a pressure of approximately 65 to 175 psi).

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Classification System plus any additional description considered necessary. If Atterberg limits, as indicated by the classification tests, are a required part of the description, the test procedures and limits will be referenced in the construction specifications.

b. Soil compaction.

(1) Test Method 100. The soil compaction test described in Test Method 100 of MIL-STD-621 or AASHTO T 99 will be used to determine the compaction characteristics of soils except as noted below. The degree of compaction required is expressed as a percentage of the maximum density obtained by the test procedure presented in MIL-STD-621 Test Method 100, Compaction Effort Designation CE 55. This is usually abbreviated as CE-55 maximum density.

(2) Other control tests. Certain types of soil may require the use of a laboratory compaction control test other than Test Method 100. This method should not be used if the soil contains particles that are easily broken under the blow of the tamper unless the field method of compaction will produce a similar degradation. Also, the unit weight of certain types of sands and gravels obtained in this method is sometimes lower than the unit weight that can be obtained by field methods; hence, this method may not be applicable. Density tests in these cases are usually made under some variation of the test method, such as vibration or tamping (alone or in combination) with some type hammer or effort other than that used in the test in order to obtain a higher laboratory density. Also, in some cases, it is necessary to use actual field compaction test sections.

c. Soil resistance.

(1) CBR test. The California Bearing Ratio (CBR) MIL-STD-621, Test Method 101 or AASHTO T 193 test will be used to evaluate the ability of soils to resist shear deformation. The CBR test is conducted by forcing a 2-inch-diameter piston into the soil. The load required to force the piston into the soil 0.1 inch (sometimes 0.2 inch) is expressed as a percentage of the standard value for crushed stone. The test is valid only when a large part of the deformation under penetration is shear deformation. The test can be performed on samples compacted in test molds, on undisturbed samples, or on material in place. The test must be made on material that represents the prototype condition that will be most critical from a design standpoint. For this reason, samples are generally subjected to a 4-day soaking period. Details of the test procedure are given in MIL-STD-621, Test Method 101. Test Method 101 is suitable for either field or laboratory application.

(2) Supplemental requirements. Laboratory CBR tests on gravelly materials often show CBR values higher than those obtained in the prototype, primarily because of the confining effect of the

6-inch-diameter mold. Therefore the CBR test has been supplemented by gradation and Atterberg limit requirements for gravelly materials.

d. Approximate relationships. Use figure 2-1 for approximate relationships between soil classifications and soil strength values when actual test results or existing information are not available.

2-4. Fill and subbase borrow areas. During reconnaissance, the site will be explored for potential borrow sources. See table 2-3 for comparative values of soils for use as subgrade and subbase; use field approximations of classifications as a guide to desirable sources. During preliminary exploration, samples of borrow materials will be taken to a depth of 2 to 4 feet below the anticipated depth of borrow on 50-foot centers. Surveys of local suppliers to determine the quality and quantity of commercially available fill materials will be made.

2-5. Availability of base and surfacing aggregate. Since these are generally crushed and processed materials, a survey should be made of the commercial suppliers in the general area. Available materials should be sampled, classified, and tested. In remote areas where commercial production is limited or nonexistent, investigate and test for quarry site location near the construction site.

2-6. Availability of other construction materials. Availability and quality of bituminous materials can be sought from the suppliers of these materials. The knowledge of the availability and type of portland cement, lime, fly ash, and other materials will also aid in the evaluation and applicability of structural layers. This information will be helpful in developing designs and alerting designers to unusual local conditions and shortages.